Dr. Johannes Meisenheimer, associate professor at Jena, has been elected professor of zoology at Leipzig, to succeed the late Professor Chun.

Dr. Paul Koebe, associate professor at Leipzig, has been elected professor of mathematics at Jena, as successor of Professor Johannes Thomae.

Discussion and Correspondence

Sunflower Problems

Professor Bateson, in his British Association address (Science, Aug. 28, 1914, p. 300), has raised the question whether the red sunflower may not owe its chestnut color to the loss of an inhibitor, instead of the positive addition of a factor for red. Are all yellow-rayed sunflowers potentially red, but prevented from becoming so by something which "stops down" the series of chemical processes which would produce redness?

So far as I can determine, the cultivated *Helianthus annuus* is derived from the wild *H. lenticularis,* which has a dark disc and orange rays. The disc florets of this plant have small triangular lobes, which are a sort of dull wine red owing to an abundance of anthocyan pigment. The rays are orange, without red. The disc bracts have dark red ends. There is evident anthocyan pigment in the stem, producing a mottled effect. Thus, it is clear that the *kind* of pigment which characterizes the red sunflower is rather abundantly present in the wild plant, although it does not invade the rays. Occasionally, however, the rays show a little red. At Longmont, Colorado, August 30, 1914, I found a plant of *H. lenticularis* having the middle third of the rays beneath with the apical half variably light brownish-red. Microscopic examination showed cells with anthocyan, which became redder with acid. On the upper side, the rays were entirely orange as usual. In the red sunflowers, it is this middle tract of the under side of the rays which is generally especially heavily pigmented. Had this Longmont plant a special "factor for red," or had some of the effects of the normal reddening factor of the disc florets spilled over, as it were, on to the rays? In our red sunflowers, we find that the heterozygous forms may be very richly colored. Nevertheless, they may be almost wholly yellow-rayed. The most extreme case of this sort is a plant grown this year, which has very purple stems and branches, but the very rich orange rays apparently wholly without red, though a lens shows a little scattered red. In this case it would seem natural to think of the red being inhibited. However, the appearance of yellow-rayed heads at the end of the season on heterozygous more or less red-rayed plants suggests not so much the late development of a special inhibitor, as the failure under adverse conditions of the color-producing mechanism. In other words the "inhibitor" here is nothing more than the withdrawal of the needful stimulus.

The monocephalous garden sunflowers have the disc yellow, the red having disappeared from the disc florets. The same variation occurs from time to time in the related wild species (*e. g.,* the variety *phenax* of *H. petiolaris*). Dark disc is strictly dominant or epistatic to yellow. Here we naturally speak of the loss of a factor; but carrying the inhibitor postulate a little farther, we can assume that we have here a second inhibitor, acting upon the disc, only operating when the plant is homozygous for it. A supposition of this sort is certainly fatiguing to the imagination.

In homozygous red-rayed sunflowers, the pigmentation may be intense.[1] We not only have the form (var. *ruberrimus,* nov.) with the rays deep chestnut red all over; but this year we obtained one (var. *niger,* nov.) with the rays practically black above, slightly red apically, though beneath they showed on one side a streak of orange. (The orange streak on one side, not always the same side, beneath, is a regular character of the very red varieties. I am not at present able to explain this asymmetry, unless it has to do with the manner

[1] It is singular that the pigmentation of the seed (fruit) follows quite different lines. Sutton's tall primrose variety of *H. annuus* has long black seeds, and in a cross with brown-seeded varieties, the seeds of F_1 come broad and dark brown.

of folding in the bud, whereby one side is deprived of light.)

In the vinous series (red on primrose) we have corresponding forms, one (var. *vinosissimus,* nov.) having the rays entirely dark wine red.

On the whole, and in view of the fact that there are no wild species of sunflowers with red rays, it seems reasonably certain that the red represents a "positive" variation; but, as with color variations in animals, there may well be also a diluting or inhibiting factor, which when present sensibly modifies the expression of the factor for red. It is not necessary, however, to suppose even this, since various degrees of stimulation might equally bring about the results. Miss Wheldale, describing analogous cases in chemical terms, suggests that if the local oxidizing capacity of any tissue is greater than its reducing power, this is indicated by the local appearance of anthocyanin; if the reducing power is greater than the oxidizing power, no pigment results. Thus, she says, the *loss* of a dioxidizing factor would produce color, as may be the case in the red-leafed beech.

Duggar found that in the tomato a red pigment (lycopin) and a yellow (carotin) both occur. In yellow varieties only the carotin occurs; but in genetically red varieties a high temperature precludes the formation of lycopin, and yellow fruits result. In the case of the red sunflowers, the red color very commonly fades more or less after the flowers open, probably in part owing to growth without corresponding increase of pigment, which thus becomes diluted. Dr. J. R. Schramm of the Missouri Botanical Garden informs me that in the hot summer of St. Louis this fading is excessive, good red forms becoming practically yellow before they are over. Also, on comparing notes with Mr. D. M. Andrews of Boulder, Dr. Schramm observed that roses with pale tints are much less colored at St. Louis than in Colorado.

With regard to a possible "dilution" factor, it is to be noted that in the series of yellow and orange pigments, which occur in visible particles, dilution can be seen, as explained in SCIENCE, August 21, 1914, p. 284. More recently we have obtained the fourth possible combination of this series, dilute orange, in plants of the *bicolor-vinosus* type.

In the paper just quoted, irregularities in the distribution of anthocyan pigments were described. I have now to record a similar peculiarity in which the solid pigments are involved. An F_2 plant from very pale *Helianthus cucumerifolius* $\times$ *H. annuus coronatus* had broad orange rays, with about the basal half strongly washed with chestnut. A single ray, however, was primrose color, slightly streaked with vinous. This ray had an orange longitudinal stripe on the under side. The difference here is only in the yellow, the difference in the red (chestnut and vinous) being entirely due to the character of the background.

A few words may be added regarding gigantism. In 1913, and again in 1914, there appeared among our red sunflowers a certain number of gigantic plants, fully ten feet high, nearly always with yellow rays. These numbered perhaps about 25 per thousand plants. The occurrence of these plants this year has been especially striking, in a large group of very good reds. One occurred, blooming very late, in the series of F_2 plants from *primulinus* $\times$ *coronatus,* which gave us our first vinous. Have we here a sort of jack-in-the-box effect, some inhibitor of growth being lacking in a certain number of cases? The *coronatus* we used had some "Russian" (var. *macrocarpus* D.C.) in its ancestry, which might bring a recessive tendency to gigantism. These large plants, however, were much branched and had dark discs.

T. D. A. COCKERELL
UNIVERSITY OF COLORADO

X-RAY DIFFRACTION PATTERNS

THE diffraction patterns discovered by Friederich, Knipping and Laue have been shown to be due to the arrangement of the atoms of crystals into planes. These patterns are used to indicate the spatial distribution of atoms in crystals.

An experiment illustrating these patterns can be very easily shown to an audience by permit-